Technical Analysis
for
Prevention of Significant Deterioration
Kuparuk, Alaska
August 1981

EPA RX

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ARCO Alaska, Inc.--Kuparuk, Alaska
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1.0 Introduction

ARCO Alaska, Inc., a subsidiary of Atlantic Richfield Company, proposes to construct additional facilities at the Kuparuk, Alaska Oil Field. These consist of additional drill sites, an expansion of the existing Central Production Facility (CPF), other production facilities, water injection facilities, additional power production capacity, and a crude oil topping unit. Emission sources for these facilities consist of 47 turbines with a combined capacity of 600,000 horsepower, 100 heaters with a combined heat input rate of 1060 MM Btu/hr, and a crude oil topping unit flare. A breakdown of the proposed emission sources is presented in Table 1-1.

The total projected emissions increases, in tons per year, from the project are summarized below:

Pollutant	Emissions	EPA Significant Emissions Level
NO_X	15,402	40
PM	373	25
CO	3,006	100
SO_2	< 99	40
VOC	64	40

TABLE 1-1
PROPOSED FACILITIES SOURCE LIST

Location	Description
Central Production Facility [CPF-1]	3-14 MHP Turbines 8-34 MHP Turbines 21-10 MMBtu/hr Heaters* Crude Oil Topping (COT) Unit Flare 1-40 MMBtu/hr COT Heater
West Production Facility - ~~CPF-3~~ [CPF-2]	8-4.9 MHP Turbines 4-14 MHP Turbines 25-10 MMBtu/hr Heaters* 1-20 MMBtu/hr Heater
North Production Facility - ~~not built~~ [CPF-3]	8-4.9 MHP Turbines 4-14 MHP Turbines 25-10 MMBtu/hr Heaters* 1-20 MMBtu/hr Heater

South Production Facility ~~- CPF-2~~ [Construction Camp]	8-49 MHP Turbines 4-14 MHP Turbines 25-10 MMBtu/hr Heaters* 1-20 MMBtu/hr Heater	

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* The 10 MMBtu/hr heaters are assigned to the production facilities for dispersion modeling purposes. In actuality, they will be constructed at sites throughout the Kuparuk Oil Field, yet to be determined.

As shown in the above table, projected emissions of NO_x, PM, CO, SO_2, and VOC are above the significant emissions levels for modified sources as defined in §52.21(b)(23)(i) of the PSD regulations. Therefore, a BACT determination and air quality analysis will be required for NO_x, PM, CO, and SO_2. Air quality review is not required for VOC because VOC emissions are less than 100 tons per year, however, a BACT determination must still be made for VOC.

2.0 Determination of Best Available Control Technology (BACT)

2.1 Definition

BACT defines an emission limitation based on the maximum degree of reduction achievable through application of process modifications and emission control systems. BACT is determined on a case-by-case basis taking into account energy, economic, and environmental impacts. BACT emission limits must not exceed New Source Performance Standards (NSPS) proposed or promulgated under 40 CFR Part 60.

2.2 BACT for the Turbines

2.2.1 NO_X and CO

Standards of Performance for Stationary Gas Turbines were promulgated on September 10, 1979, for NO_X. These standards limit NO_X emissions from turbines used for oil or gas transportation and production to 150 ppm at 15 percent oxygen on a dry basis. The NO_X emission limit for gas turbines is modified by a turbine efficiency factor, and the source test results must be adjusted to (ISO) standard day conditions.

The two best systems available for reduction of NO_X from combustion turbines are dry (internal combustion) controls and injection of water or steam. Dry controls are incorporated into the design of the turbine combustion chamber by the manufacturer. Water or steam injection lowers the peak combustion temperature in the turbine and, therefore, reduces the amount of NO_X formed. NO_X emissions of less than 75 ppm at 15 percent oxygen can be achieved with water or steam injection.

Water or steam injection to limit NO_x emissions is infeasible at the Kuparuk operation primarily because of its geographic location. Alaska's North Slope has a shortage of fresh water, a fragile environment, and is extremely cold during much of the year. Fresh water must be used for turbine injection and requires carefully monitored pH and extremely low minerals and dissolved and suspended solids contents. The cost for facilities to produce water of this quality would be prohibitive for ARCO Alaska, Inc. In addition, the available fresh water in this region is often frozen and contains a relatively high concentration of dissolved solids and related impurities. Alaska also has strict laws regulating commercial water use in order to protect fish and wildlife. These problems would have to be overcome before water injection could be considered. The cost to ARCO Alaska, Inc., would be much greater than that typical for the "lower 48," due to the required storage of water for use during low flow periods, installation of water treatment facilities, and increased energy costs to keep the water from freezing during cold periods.

Dry controls can reasonably be expected to limit NO_x emissions to the NSPS value of 150 ppm at 15 percent O_2. There is some evidence indicating that even lower levels are achievable using dry controls. One manufacturer plans to guarantee a NO_x emission level of less than 100 ppm using dry controls for turbines greater than 40 MHP. The turbine at Alyeska pump station No. 2 was source tested in 1980 and found to emit about 80 ppm NO_x. A number of the gas turbines at Prudhoe Bay have been tested for NO_x emissions. The test results showed NO_x emissions of 40-80 ppm. However, this set of data does not justify a lower emission limit, and so 150 ppm is still considered BACT.

Incomplete combustion is the primary cause of carbon monoxide (CO) emissions from stationary gas turbines. CO emissions can best be reduced by maintaining proper combustion conditions by regulating fuel to air ratios, mixing, and combustion temperatures. Since documented evidence is unavailable to indicate that better control is available for CO emissions, the emission limitation based upon natural gas as the fuel and representative of BACT for CO is calculated to be 109 lb/MM scf of fuel used.

2.2.2 PM, SO_2 and VOC

No effective controls have been demonstrated for reducing PM emissions from gas turbines. Therefore, a level of emissions equal to that specified in the AP-42 emission factors is judged to represent BACT. For 600 MHP of turbine capacity, this level corresponds to PM emissions of 373 tons per year.

The company proposes to control SO_2 emissions from the turbines by limiting the H_2S concentration of the fuel gas to 20 ppm. This will result in an outlet concentration well

below the NSPS limit for gas turbines of 150 ppm. Therefore, this level of SO_2 control is considered BACT. This corresponds to SO_2 emissions of 73 tons per year.

No effective controls have been demonstrated for reducing VOC emissions from gas turbines. Therefore, a level of emissions equal to that specified in the AP-42 emission factors is considered to represent BACT. For 600 MHP of turbine capacity, this corresponds to VOC emissions of 53 tons per year.

2.3 BACT for the Process Heaters

2.3.1 NO_X and CO

For the process heaters, BACT Must be determined for NO_X and CO. NSPS regulations for process heaters have not been proposed or promulgated as of this time. However, the NSPS for fossil fuel fired steam generators will be used for comparison. These regulations include an NO_X emission limit for gas-fired units of 0.20 lb NO_X/MM BTU and a 25 percent reduction from potential emissions for fossil fuel fired steam generators with a capacity greater than 250 x 10MM BTU/hr. Although none of the proposed heating units have a capacity greater than 250 X MM BTU/hr, this NSPS will be used as a comparison in the analysis that follows.

The company proposed to limit NO_X by burning natural gas. Other NO_X reduction processes such as off-stoichiometric combustion, minimizing excess air to the combustion process, and flue gas recirculation were considered but rejected either because of the remoteness of the source or the relatively small size of the process heaters.

Low NO_X burners reduce NO_X emissions by improved fuel-air mixing, lower peak flame temperatures, oxygen deficient combustion, and flue gas recirculation. These burners have been shown to reduce emissions to the range of 40-75 ppm which represents a 60-75 percent reduction from the maximum AP-42 emission factor. These burners can reasonably be expected to reduce NO_X emissions to less than 70 ppm or 35 ng/J (.08 lb MM BTU). The use of low NO_X burners on process heaters would result in a substantial decrease in emissions over natural gas firing alone. Low NO_X burners should not require dramatically increased upkeep or initial capital costs over other types of burners; therefore, BACT for the process heaters will be set at .08 lb $NO_X/10^6$ BTU (35 ng/J) for heaters rated at 43 MM BTU/Hr or greater.

For heaters with a capacity of less than 43 MM BTU/Hr., low NO_X burners are also considered BACT. But the emission for these heaters should be slightly higher. This takes into account the higher oxygen levels for natural draft systems, which the smaller heaters could be expected to use.

Assuming 4% excess oxygen, an emission limit of 0.1 lb/MM BTU is considered BACT for heaters rated at less than 43 MM BTU/Hr.

CO from process heaters are minimized by burning gas rather than oil and by monitoring combustion parameters to maintain good combustion. Either oxygen or carbon monoxide levels in the combustion flue gas can be used as an indicator of good combustion; therefore, the installation of either continuous CO or O_2 monitors or the implementation of an acceptable periodic monitoring program will be required for all of the process heaters. CO or O_2 monitoring and gas firing will be considered BACT for the process heaters. The CO emission limit for the process heaters is based upon the use of natural gas as the fuel and is calculated to be 0.018 lb/MM BTU.

2.3.2 PM, SO_2 and VOC

No effective controls have been demonstrated for reducing PM emissions from process heaters. Therefore, a level of emission equal to that specified in the AP-42 emission factors is judged to represent BACT. For 1060 MM BTU/hr of heater capacity, this level corresponds to PM emissions of 63 tons per year.

The company proposes to control SO_2 emissions from the heaters by limiting the H_2S content of the fuel gas to 20 ppm. No effective controls have been demonstrated for achieving lower SO_2 emission levels. Therefore, this level of control is considered BACT. This corresponds to annual emissions of 13 tons per year.

No effective controls have been demonstrated for reducing PM emissions from process heaters. Therefore, a level of emission equal to that specified in AP-42 is considered to represent BACT. This corresponds to VOC emissions of one-ton per year.

mean VOCs

2.4 BACT for the COT Flare

The company proposes to limit the online time of the COT Flare to emergency use only (1 percent of total operating time). Therefore, no BACT analysis is required for this unit.

3.0 Ambient Air Quality Analysis

From the information given in the previous section, operation of the proposed additional facilities at the Kuparuk, Alaska Oil Field will result in significant increases of emissions of the following pollutants: Oxides of nitrogen (NO_x), particulate matter (PM) carbon monoxide (CO), volatile organic compounds (VOC), and sulfur dioxide (SO_2). PSD regulations require that an ambient air quality

analysis must be conducted for each of these pollutants except for VOC. Regulations require air quality review for O_3 (ozone) only if VOC emissions increases are 100 tons/year or more. According to PSD regulations the company must demonstrate through an approved air quality analysis that the proposed project will not result in exceedances of any applicable National Ambient Air Quality Standards (NAAQS) or applicable PSD increments. The air quality analysis may also show that addition of the proposed sources will result in increases of ground-level pollutant concentrations that are less than EPA Levels of Significant Ambient Impact (LSI), which would mean that further air quality review would not be necessary. The applicable NAAQS, PSD increments, and LSI are listed in Table 3-1.

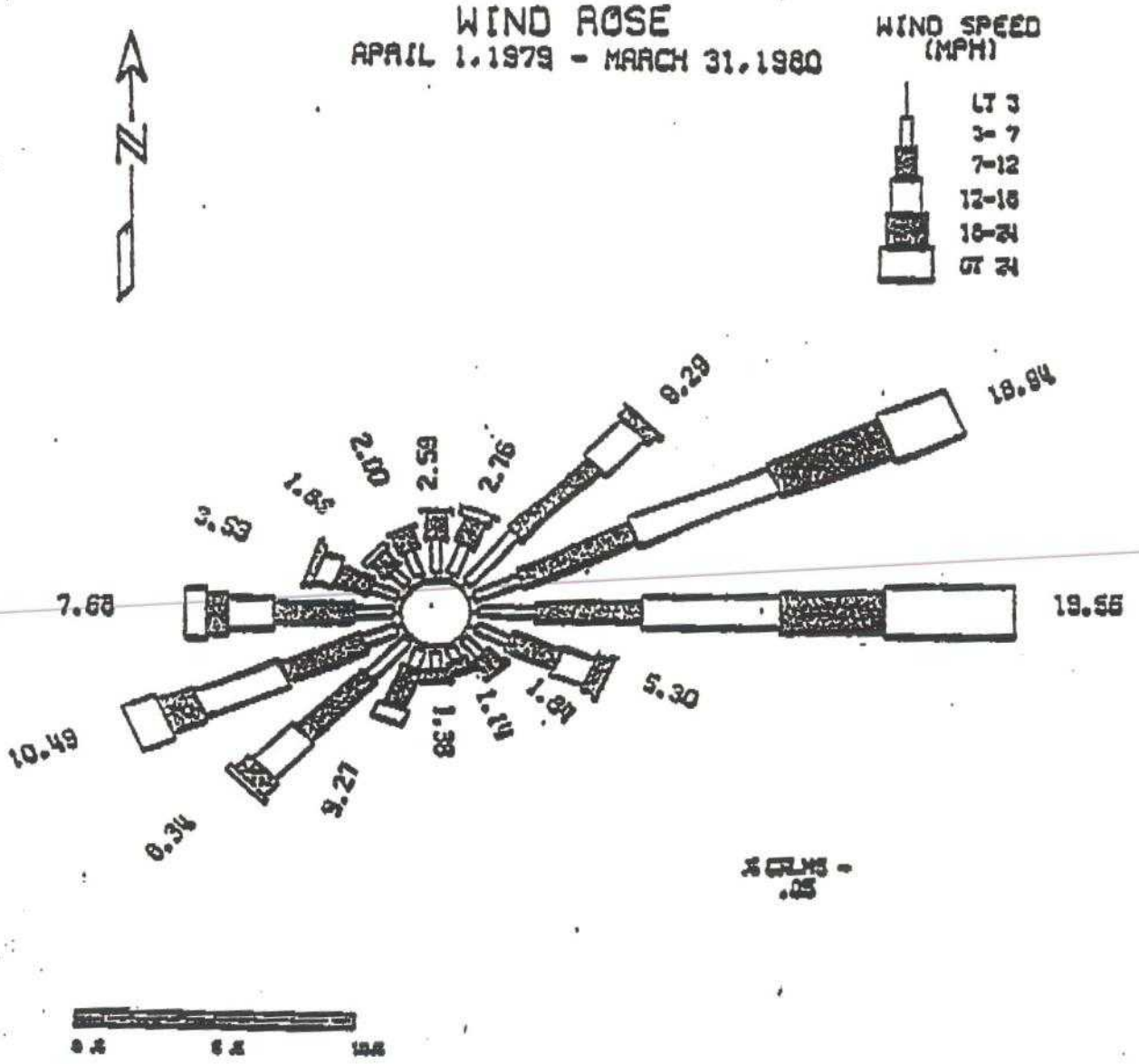
3.1 Existing Conditions

Additional facilities will be constructed to continue the development of the Kuparuk Oil Field. The Kuparuk Oil Field is an onshore oil field located on the North Slope of Alaska. The proposed oil field area will cover about 210 square miles. The center of the oil field will be located about 40 kilometers (Km) west of the Prudhoe Bay Oil Field, about 175 Km east-southeast of Barrow, Alaska and 16 Km south of Harrison Bay on the Beaufort Sea.

The topography and land use of the Kuparuk area are nearly identical to that of the Prudhoe Bay area, which is characterized by relatively flat terrain that gradually slopes downward from the foothills of the Brooks Mountains to the coast of the Arctic Ocean.

A one-year (April 1, 1979 to March 31, 1980) air quality and meteorological monitoring program was conducted in the Prudhoe Bay area. Data from this monitoring study showed the Prudhoe Bay area to be in compliance with all NAAQS. This monitoring study is described in the Arco/Sohio PSD IV, PSD Application. It also can be concluded from this study that air quality levels in the Kuparuk area are in compliance with all NAAQS because the Kuparuk Oil Field is located in a remote area only 40 Km from the existing Prudhoe Bay facilities. For this reason, the background air quality pollutant levels measured in the Prudhoe Bay area are considered to be representative of the Kuparuk area. These background levels can be used in this air quality analysis, if all of the existing, previously permitted, and proposed Kuparuk and Prudhoe Bay sources are included in the air quality analysis. The background pollutant levels used in the air quality analysis are listed in Table 3-1.

The Kuparuk area has a very harsh, Arctic climate characterized by extremely cold winters and very cool summers. Dispersion conditions in the area are generally good, primarily because of the good ventilation provided by frequent moderate to strong winds. Poor dispersion conditions do occur during stable conditions when winds are very light, but periods of poor dispersion are not frequent. This becomes evident by an investigation of Table 4-1 of the addendum to the Arco/Sohio PSD IV PSD Application which shows that extremely stable (Class F) conditions occur only 5.8 percent of the time in the Prudhoe Bay area and slightly stable (Class E) conditions occur only 7 percent of the time.



PRUDHOE BAY - WELL PAD A
(MONITOR SITE 1)

Figure 3-1

Meteorological data used in the air quality analysis was obtained from the Prudhoe Bay Monitoring Study. A detailed description of the monitoring study and the methodology used in processing the data for use in dispersion modeling is contained in the Arco/Sohio PSD IV, PSD Technical Analysis Document. The meteorological data gathered in the Prudhoe Bay area is considered to be representative of dispersion conditions in the Kuparuk area because of the close proximity of the two oil fields (the Kuparuk Area Central Production Facility is 36 Km west-northwest of Prudhoe Bay Well Pad A) and because of similarities in terrain between the two areas. A comparison of the wind rose for Well Pad A (Monitor Site 1) shown in Figure 3-1 with the 1976 wind rose for Deadhorse Airport (15 km southeast of Monitor Site 1) and the 1958-1964 and 1968-1977 wind roses for Barter Island (220 km east of Monitor Site 1) show that wind speeds and wind directions measured at Monitor Site 1 are representative of regional climatic conditions. Therefore, the Prudhoe Bay meteorological data was considered to be appropriate for this air quality analysis.

For short-term modeling, pre-processed hourly meteorological data from the Prudhoe Bay monitoring network were used. For annual modeling, a joint frequency distribution of wind speed, wind direction, and stability class was developed from the one year of hourly data and was used as meteorological input. Both wind speed and wind direction data from Monitor Site 1 were used in the air quality analysis.

Mixing heights computed from the modified PREP pre-processor program were used in the air quality analysis for the entire monitoring study period except for Oct. 2, 1979 through Feb. 2, 1980. Mixing height data collected by an acoustic sounder was used during this time period. For a detailed description of the acoustic sounder refer to the Air Quality and Meteorological Monitoring Study at Prudhoe Bay, Alaska, Jan., 1981, and for a description of the modified PREP pre-processor program refer to the Prudhoe Bay Unit Owners' Waterflood PSD Application.

3.2 Emission Characteristics

The stack parameters and pollutant emission rates for all existing, previously permitted, and proposed sources in the Kuparuk and Prudhoe Bay areas which were used in the air quality analysis are listed in Appendix A of the Arco-Kuparuk PSD Application.

Most of the proposed Kuparuk sources will have stack heights less than good engineering practice (GEP) stack heights as determined by the proposed EPA regulations (Federal Register, Vol. 44, No. 9, Jan. 12, 1979). High ground-level pollutant concentrations can result from pollutant emissions from stacks of heights less than GEP recommended heights due to building-wake-induced downwash of pollutants. Consequently, downwash was considered in the modeling analysis for all proposed, existing, and previously permitted Kuparuk and Prudhoe Bay sources which have stack heights lower than GEP recommended heights. The modeling approach used in the downwash analysis is described in the next subsection.

Model Methodology

The proposed Kuparuk sources were modeled with existing, previously permitted, and proposed sources in the Kuparuk and Prudhoe Bay areas to determine compliance with NAAQS. To determine compliance with PSD increments, all increment-consuming sources were modeled together. Increment-consuming sources are defined as all sources constructed or permitted after the baseline date for a particular pollutant. Baseline dates are pollutant-specific and are established for an area by the date after August 7, 1977 that the first completed PSD application for a major modification or major stationary source subject to EPA's PSD regulations as amended on August 7, 1980 is submitted. The complete application receipt date is the baseline date for each pollutant which is emitted in greater than significant amounts. The baseline date for PM was set on Nov. 13, 1978 by the Prudhoe Bay Unit Owners PSD I Application, and the baseline date for SO_2 was set on April 2, 1981 by the Prudhoe Bay Unit Owners PSD IV Application.

In this air quality analysis the proposed Kuparuk sources of PM and SO were modeled as increment-consuming sources, while existing and previously permitted Kuparuk sources are not considered increment-consuming sources.

Short-term modeling was done through the use of the rural version of the Industrial Source Complex Short-Term (ISCST) Model and the PTPLU Model. Long-Term modeling was done through the use of the rural version of the Industrial Source Complex Long-Term (ISCLT) Model. The short-term and long-term versions of the ISC Model are described in detail in the Industrial Source Complex (ISC) Dispersion Model User's Guide, Vol. 1, EPA-450/4-79-030, Dec., 1979. The PTPLU Model is described later in this subsection. The use of the rural version of the ISC Model rather than the urban version of the model is based on a classification scheme described in "Guidelines on Air Quality Models," Proposed Revisions, EPA, Oct., 1980. The scheme allows an area to be classified urban or rural based on land use.

The ISC Model is not listed as a recommended model in EPA's "Guideline on Air Quality Models" (EPA-450/2-78-027, April, 1978) which is currently in force. However, the ISC Model has been proposed as a guideline model and is included in the "Regional Workshops on Air Quality Modeling - A Summary Report," April, 1981.

At this time, the ISC Model has not been thoroughly evaluated and it is still being tested. One evaluation study has shown that for plumes subject to building-wake effects, the building-wake-effects option of the ISC Model significantly improves the performance of the ISC Model over that of the corresponding models (CRSTER and MPTER), which do not consider building-wake effects when used to calculate concentrations near the source. Data sets in this study were not sufficient in number and detail to validate new features of the model, however, it was possible to compare the performance of the ISC Model with the CRSTER and MPTER models. This study is described in detail in "An Evaluation Study for the Industrial Source Complex (ISC) Dispersion Model," EPA-450/4-81-002, Jan., 1981.

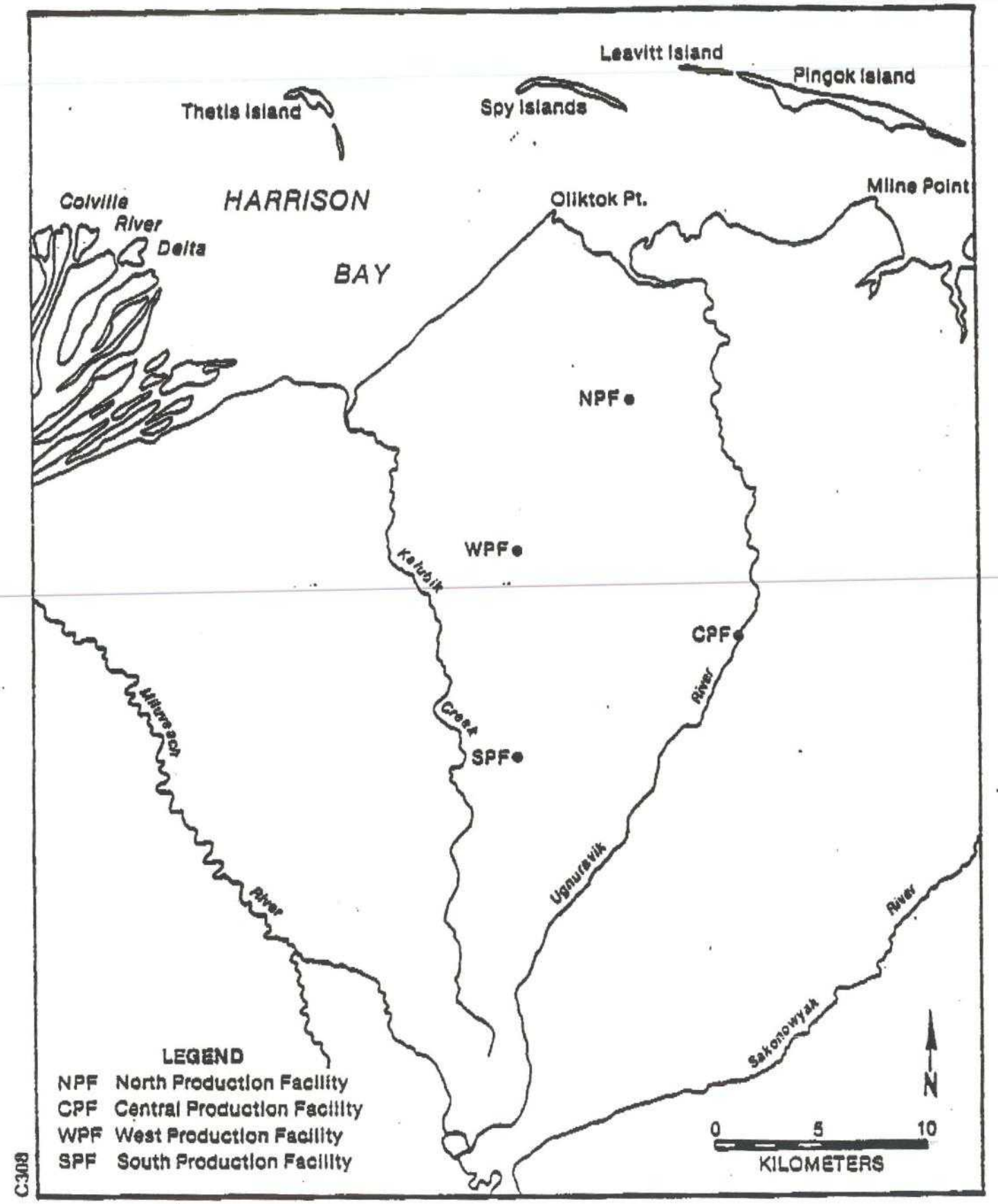


Figure 3-2. Location of Proposed Facilities in the Kuparuk Area

The ISC Model was used in this air quality analysis because building-wake-induced downwash of pollutants was viewed as a potential problem, and the ISC Model is the most suitable available model for use in calculating downwash of pollutants. The model was also judged to be appropriate for use in the Kuparuk/Prudhoe Bay area because the terrain of the area is relatively flat. Since ISC is technically a non-Guideline Model, EPA hereby approves of its use for this application. EPA regulations require that notice and opportunity for public comment be given on this proposed approval.

Pre-processed hourly meteorological data collected in the Prudhoe Bay Monitoring Study were input into the ISCST Model. The annual stability wind rose constructed from the Prudhoe Bay Monitoring Study was used as meteorological input for long-term modeling with ISCLT.

The modeling approach used in determining compliance with PSD increments and NAAQS for each pollutant subject to air quality review follows:

3.3.1 NO_2

A screening analysis with ISCST was performed for the proposed Kuparuk Oil Field sources and for all Prudhoe Bay sources. All existing and proposed Kuparuk emission sources were assumed to be distributed equally and colocated at the four Kuparuk Oil Field production facilities. This assumption could lead to overpredictions of ground-level NO_x concentrations. The locations of the four Kuparuk Oil Field production facilities are shown in Figure 3-2. Pollutant sources at Prudhoe Bay were also included in this analysis. An 8 by 5 receptor grid with a 0.25 Km spacing was modeled around each facility. This analysis revealed that annual NO_x concentrations from the proposed Kuparuk sources exceeded significant levels at receptors located in the Prudhoe Bay Oil Field. The analysis also showed the Prudhoe Bay sources to have significant impacts at receptors located in the Kuparuk Oil Field. Therefore, ISCLT modeling runs were performed for all Prudhoe Bay and Kuparuk sources of NO_x. From these runs four areas of maximum impact were identified for more refined modeling. These "maximum impact areas" were located around the Central Processing Facility (CPF) and the Southern Processing Facility (SPF) in the Kuparuk Oil Field, and around Gathering Center 2 (GC-2) and Flow Station 1 (FS-1) in the Prudhoe Bay area. The locations of the proposed Kuparuk sources are shown in Figure 3-2. The locations of the Prudhoe Bay facilities are shown in Figure 1 of the Arco/Sohio PSD IV, PSD Technical Analysis Document.

The Ozone Limiting Method was used in the refined modeling analysis to determine maximum annual NO_2 concentration levels from the predicted NO_x concentrations. This method is described in a paper titled "A Review of Techniques Available for Estimating Short-Term NO_2 Concentrations,"

Cole and Summerhays, 1979. This method assumes that 10 percent of the oxides of nitrogen (NO_x) emitted is converted "in-stack" to NO_2. The remaining 90% of the NO_x emitted is oxidized to NO_2 by the available atmospheric O_3 present. The amount of NO_2 formation is restricted by the amount of O_3 present. The background O_3 concentration of 51 ug/m^3 was used in this analysis because it was assumed that existing Prudhoe Bay and Kuparuk sources did not contribute to the ambient O_3 concentration.

To determine compliance with NAAQS, the maximum NO_2 concentrations predicted by the above method were added to the background NO_2 levels. The results of this analysis are listed in the next subsection.

3.3.2 CO

CO emissions from the proposed Kuparuk Oil Field sources were modeled through the use of the EPA PTPLU Model. The model calculates maximum downwind pollutant concentrations along the plume centerline for an array of wind speeds and stability classes. The output consists of the maximum one-hour concentration for each wind speed and stability combination and the distance from the source at which it occurs. The maximum CO concentrations predicted for each source were added together to determine the maximum one-hour CO impact. This modeling approach will likely result in the overprediction of ground-level CO concentrations for the following reasons: 1) Maximum concentrations were assumed to occur at the same receptor. 2) Maximum concentrations were summed without consideration given to differences in the wind speed and stability class associated with each individual maximum.

The maximum 8-hour CO concentration was obtained by multiplying the maximum one-hour CO impact by 0.7. This methodology is in accordance with "Procedures for Evaluating Air Quality Impact of New Stationary Sources" (EPA-450/4-77-001). The maximum one-hour CO impact was considerably less than the one-hour LSI, however, the maximum 8-hour CO impact was slightly above the 8-hour LSI. Further air quality review was not conducted for CO because it was felt that the conservative assumptions mentioned above resulted in the overprediction of ground-level CO concentrations, which suggests that maximum CO concentration values would likely be below the LSI for the averaging times of concern. The results of this analysis are listed in the next subsection.

3.3.3 SO_2

To determine short-term SO_2 impacts from the Kuparuk facilities, emissions of SO_2 were input into the ISCST Model. Receptors were placed in circular rings at distances of 0.25 Km, 0.5 Km, and 1.0 Km around the CPF and SPF.

Receptors were not placed around the remaining Kuparuk facilities because SO_2 emissions from these facilities were the same as SO_2 emissions from the SPF. Therefore, if SO_2 impacts from the SPF exceeded significance levels at the SPF, then significance levels would also be exceeded at the other facilities and additional modeling would be necessary around these facilities. This screening analysis showed that SO_2 concentrations would exceed 3-hour and 24-hour LSI around the CPF only. For this reason, additional modeling was conducted only around the CPF. The "worst-case" periods for 3-hour and 24-hour SO_2 impacts were identified from the screening analysis. More refined modeling was conducted around the CPF for these "worst case" periods. Receptors were only placed around the CPF in the refined short-term analysis.

The same screening technique for determining annual NO_x and PM impacts from the Kuparuk facilities was also used for determining annual SO_2 impacts. The screening analysis showed that annual SO_2 impacts would exceed LSI around the CPF only. Refined modeling was performed around the CPF for an 8 by 5 receptor grid with a 0.25 Km grid spacing. All Kuparuk sources were included in the refined analysis.

The maximum SO_2 impacts from the proposed Kuparuk sources are compared to applicable PSD increments in the next subsection. To determine compliance with applicable NAAQS, the maximum SO_2 impacts from all Kuparuk sources were added to the SO_2 background levels. Results of this analysis are listed in the next subsection.

3.3.4 PM

Throughout this analysis emissions and concentrations of particulates are expressed as particulate matter (PM). The same short-term screening technique was used in determining short-term PM impact areas and "worst case" days as was used in the short-term SO_2 screening analysis. This screening analysis showed that significant 24-hour PM impacts will occur near the four major Kuparuk facilities which are shown in Figure 3-2. In the refined analysis, 6 by 6 receptor grids with 0.1 Km grid spacings were placed around the areas of maximum impact determined from the screening analysis.

The same screening technique for determining annual NO_x and SO_2 impacts from the proposed Kuparuk facilities was also used for determining annual PM impacts. The screening analysis showed annual PM impacts to be above the LSI around the four major Kuparuk facilities. No significant impacts from the Kuparuk facilities were predicted to occur in the Prudhoe Bay Oil Field area. Refined modeling with an 8 by 5 receptor grid and 0.25 Km spacing was conducted around each major Kuparuk facility.

Maximum PM impacts from the proposed Kuparuk sources are compared to applicable PM increments in the next subsection. Maximum PM impacts from all Kuparuk sources were added to PM background levels to determine compliance with applicable NAAQS. The results of this analysis are listed in the next subsection.

3.4 Model Results

The maximum predicted concentrations for each pollutant are compared to applicable NAAQS, PSD increments, and LSI in Table 3-1.

TABLE 3-1

Comparison of Estimated Maximum Impacts from the Proposed Kuparuk Sources with Applicable National Ambient Air Quality Standards (NAAQS), PSD Increments, and Levels of Significant Ambient Impact(LSI).

All concentrations are in micrograms per cubic meter

Pollutant	Averaging Time	Proposed Kuparuk Sources*	LSI	Class II PSD Increment	All Sources	Measured Background	Total	NAAQS
SO_2	3 hours	123	25	512	140	0	140	1,300
	24 hours	16	5	91	16	0	16	365
	Annual	2	1	20	2	0	2	80
PM	24 hours	26	5	37	26	11	37	150
	Annual	1	1	19	3	11	14	60
CO	1 hour	757	2,000	**	***	171	-	40,000
	8 hours	530	500	**	***	171	-	10,000
NO_2	Annual	1	1	**	62	2	64	100

* Proposed Kuparuk sources are increment-consuming sources, while existing and previously licensed Kuparuk sources are not increment-consuming sources.

** No PSD increments exist for CO and NO_2.

*** Further air quality review was not conducted because the conservative air quality analysis showed one-hour CO impacts to be well below the level of significant ambient impact.

3.4.1 NO_2

Maximum annual NO_2 concentrations are predicted by the ISCLT Model to occur at points of 0.25 Km to the lee side of the four major Kuparuk facilities and to the lee side of several of the Prudhoe Bay sources. This suggests that these concentration maxima are the result of building-induced downwash. The maximum annual NO_2 concentration occurred 0.25 Km to the west of GC-2 in the Prudhoe Bay Oil Field, while the second highest NO_2 concentration was predicted to occur 0.25 Km west of the CPF in the Kuparuk Oil Field. These predicted concentration values were 64 micrograms per cubic meter (ug/m) and 58 ug/m^3 respectively - less than the annual NAAQS of 100 ug/m^3. There exists some uncertainty whether these impacts would occur because the Prudhoe Bay and Kuparuk buildings are built on elevated structures, which may minimize the effects of building-wake-induced downwash. If downwash did not occur, model predictions would be overestimates in the lee of buildings. It should be noted, however, that the addition of previously permitted and proposed sources of NO_X will result in a general significant increase (20 ug/m^3 to 30 ug/m^3) in NO_2 levels in the Prudhoe Bay and Kuparuk areas. This is illustrated by comparing Figure 6-2 of this PSD application and Figure 4-1 of the Arco/Sohio PSD IV, PSD Application with Figure 9.2-3 of the Prudhoe Bay Unit Owner's PSD I Application.

3.4.2 CO

The maximum CO impacts were determined for "worst case" meteorological conditions for all of the proposed Kuparuk sources. Table 3-1 shows that maximum one-hour CO impacts are considerably less than one-hour LSI and that the maximum 8-hour CO impact is close to the 8-hour LSI. It is expected that CO impacts will be less than these predicted values due to the conservative assumptions in the air quality analysis that were discussed in the previous subsection.

3.4.3 SO_2

The maximum 3-hour SO_2 concentration was predicted to occur 0.1 Km south-southeast of the CPF on Julian day 47 from hours 1 through 3. This period was characterized by light winds and F stability. The maximum 24-hour SO_2 impact was predicted to occur 0.1 Km west of the CPF on Julian day 274, which was characterized by strong winds (10 to 16 meters per second) and neutral (Class D) stability. Maximum annual SO_2 impacts are expected to occur 0.25 Km to the west of the CPF. Table 3-1 shows that the proposed Kuparuk sources will not result in exceedances of any NAAQS or PSD increments for SO_2.

3.4.4 PM

The point of maximum 24-hour PM impact from the proposed Kuparuk sources is expected to be 0.16 Km west of the SPF (Southern Production Facility) on Julian day 272, which was characterized by D stability and wind speeds from 8 to 12 meters per second. The maximum annual PM impact was predicted to occur 0.25 Km to the west of the CPF. Table 3-1 shows that the proposed project will not result in violations of any NAAQS or PSD increments for PM.

3.5 Other Impacts

3.5.1 Class I Areas

The closest Class I area to the Kuparuk area is Mt. Mckinley National Park which is located about 750 Km to the south. No significant impacts from the Kuparuk facilities are expected at this large distance.

3.5.2 Soils/Vegetation

Particulates, NO_2, and SO_2 are adsorbed on the soil surface resulting in the formation of particulate nitrates and particulate sulfates. These pollutants are also adsorbed on plant surfaces. In general, soils and vegetation are expected to act as a sink for most of the pollutants from the Kuparuk Oil Field sources. It appears that quantities of pollutants added to the soil, as the result of the proposed sources, will be insignificant compared to that normally present in these soils.

No information is currently available on the tolerance levels of high Arctic plants. However, probable impacts on Arctic plants can be inferred from the tolerance levels determined for plants native to lower latitudes. Pollutant concentrations resulting from all Kuparuk sources will be much less than the tolerance levels determined for lower latitude plants.

3.5.3 Visibility

Increased particulates and aerosols resulting from conversion of NO_x emissions to nitrates could potentially result in some impairment of visibility in the Kuparuk and Prudhoe Bay areas. Increases in particulate emissions due to operation of the proposed facilities are not large. Therefore, little visibility degradation from particulates is expected. Increases in SO_2 emissions due to the proposed facilities are also small. Consequently, the conversion of SO_2 to sulfates is expected to result in small increases in sulfate concentrations. For this reason, sulfates are not expected to contribute to visibility degradation in the Kuparuk and Prudhoe Bay areas.

When NO_2 is emitted in sufficient quantities, a reddish-brown plume may result. NO_2 plumes may be visible for a short distance downwind of the Kuparuk facilities at times. This may result in some local degradation of visibility.

Enhancement of ice fog in the Kuparuk area may result from the proposed plumes, exhausts from the associated additional vehicles and buildings, and the respiration of the increased number of people in the area. This enhancement of ice fog may result in an increase in duration and frequency of occurrence of the already-existing reduction of visibility in the Kuparuk area.

3.5.4 Growth Impacts

The operation of the proposed Kuparuk facilities is expected to result in 300 additional people in the work force in the Kuparuk area. Increased pollutant emissions resulting from this additional work force will be mostly limited to emissions from motor vehicles. These emissions will be very small when compared to the emissions from the proposed gas heaters and turbines. Therefore, no significant air quality impacts are expected to result from the increased population in the Kuparuk area.

4.0 Findings and Recommendations

Based on the air quality analysis, the operation of the proposed Kuparuk sources is not expected to result in the violation of any PSD increments or NAAQS.

4.1 Emission Limitations

Maximum allowable emissions from the proposed modification are summarized below:

Equipment	Pollutant	Limit (t/yr)
Gas Turbines	NO_x	14,454
"	VOC	53
"	CO	2,892
"	PM	317
"	SO_2	73
Process Heaters	NO_x	308
"	VOC	1
"	CO	72
"	PM	63
"	SO_2	13

These are annual limits for the facilities listed in Table 1-1.

In addition, specific performance limits for the turbines and heaters are as follows:

Equipment	Pollutant	Emission Limit
Gas Turbines	NO_x^*	150 (14.4/Y) ppm*
	CO	109 lb/MM scf of fuel used
		10 percent Opacity
Process Heaters	NO_x	0.08 lb/MM BTU (a)
		0.1 lb/MM BTU (b)
	CO	0.018 lb/MM BTU

*NO_x emissions factor for gas-fired turbines is modified by an efficiency factor (Y = manufacturer's rated heat rate at rated peak load) which cannot exceed 14.4 kilojoules/ watt-hour. Based at 15 percent oxygen on a dry basis.

(a) - Applies to units of 43 MM BTU/hr. or greater.
(b) - Applies to units less than 43 MM BTU/hr.

4.2 Compliance Determination

Compliance with the emission limitations shall be demonstrated by the Company conducting source tests and a program of emissions monitoring as described below.

(1) Compliance testing shall be conducted within 60 days after achieving the maximum production rate at which the turbines or process heaters will be operated but not later than 180 days after startup of the specific emission source. The NSPS testing requirements for NO_x from gas turbines (40 CFR 60.335) shall be followed. The Company may submit for EPA approval an alternative test plan for the gas turbines addressing such alternatives as factory testing rather than onsite testing and testing of a certain proportion of the gas turbines from each model group rather than each individual gas turbine. EPA Method 7 shall be used for NO_x from the process heaters. Only one of each kind of process heater must be tested. The Company shall submit a test plan to EPA for approval to demonstrate that the process heater tested is representative of the process heaters for which testing is exempted. No compliance testing is required for CO.

(2) Compliance Monitoring--In addition to the NSPS requirements (40 CFR 60.334) one of the following monitoring schemes is required: (a) a continuous monitoring system shall be installed to monitor CO or O_2 for all gas-fired process heaters. These monitors shall comply with the specification requirements in Appendix B of 40 CFR Part 60; or (b) a periodic monitoring program for the process heaters using a portable CO or O_2 analyzer. The Company shall submit a monitoring plan to EPA for approval prior to startup describing the details of the program such as monitoring frequency, proposed instrumentation, quality assurance procedures, and recordkeeping.

(3) The Company shall report any use of the COT flare, including the time, duration and reason for that use. This data shall be available to EPA upon request and maintained for a period of 2 years from the date recorded.